Landolt-Börnstein
Numerical Data and Functional Relationships in Science and Technology
New Series / Editor in Chief: W. Martienssen

Group VIII: Advanced Materials and Technologies
Volume 1

Laser Physics and Applications

Subvolume A: Laser Fundamentals

Part 1

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Springer

ISSN 1619-4802 (Advanced Materials and Technologies)

ISBN-10 3-540-44379-7 Springer Berlin Heidelberg New York
ISBN-13 978-3-540-44379-7 Springer Berlin Heidelberg New York

Library of Congress Cataloging in Publication Data:
Landolt-Börnstein: Numerical Data and Functional Relationships in Science and Technology, New Series.
Editor in Chief: W. Martienssen.
Group VIII, Volume 1: Laser Physics and Applications. Subvolume A: Laser Fundamentals. Part 1.
Edited by H. Weber, G. Herziger, R. Poprawe.
Springer-Verlag, Berlin, Heidelberg, New York 2004.
Includes bibliographies.
1. Physics - Tables. 2. Chemistry - Tables. 3. Engineering - Tables.
I. Börnstein, Richard (1852-1913). II. Landolt, Hans (1831-1910).
QC 61.23 502'.12 62-53136

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Printed in Germany

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Cover layout: Erich Kirchner, Heidelberg
Typesetting: Authors and Redaktion Landolt-Börnstein, Darmstadt
Printing and Binding: AZ Druck, Kempten (Allgäu)

SPIN: 1050 7868 63/3020 - 5 4 3 2 1 0 – Printed on acid-free paper

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Preface

The three volumes VIII/1A, B, C document the state of the art of "Laser Physics and Applications". Scientific trends and related technological aspects are considered by compiling results and conclusions from phenomenology, observation and experience. Reliable data, physical fundamentals and detailed references are presented.

In the recent decades the laser source matured to a universal tool common to scientific research as well as to industrial use. Today a technical goal is the generation of optical power towards shorter wavelengths, shorter pulses and higher power for application in science and industry. Tailoring the optical energy in wavelength, space and time is a requirement for the investigation of laser-induced processes, i.e. excitation, non-linear amplification, storage of optical energy, etc. According to the actual trends in laser research and development, Vol. VIII/1 is split into three parts: Vol. VIII/1A with its two subvolumes 1A1 and 1A2 covers laser fundamentals, Vol. VIII/1B deals with laser systems and Vol. VIII/1C gives an overview on laser applications.

In Vol. VIII/1A1 the following topics are treated in detail:

Part 1: Fundamentals of light-matter interaction

This part compiles the basic elements of classical electromagnetic wave theory, non-relativistic quantum mechanics of the two-level system and its interaction with the non-quantized radiation field. The relevant relations with their approximations and range of validity are discussed. It starts with Maxwell's equations, wave equation and SVE-approximations, presents the Schrödinger equations, the field/atom interaction including the Einstein coefficients and cross-sections. The main parameters characterizing the two-level system with typical numbers are given in several tables. Finally, the coherent interaction is briefly discussed. This semiclassical approach is sufficient for most applications in laser technology. The fully quantized theory is offered in Vol. VIII/1A2, Chap. 5.

Part 2: Radiometry

In the first section the definitions of the radiometric quantities and their measurement are summarized. In the second part the main elements of laser beam characterization are compiled with a detailed discussion of the theoretical background. The experimental determination of the essential quantities according to the ISO-normalizations is given.

Part 3: Linear optics

The design of optical resonators and beam handling requires a broad knowledge in optics. In this part the fundamentals of beam propagation, Gaussian beams, diffraction, refraction, lens design and crystal optics are presented. The extensive references give access to detailed information.

Part 4: Nonlinear optics

Nonlinear effects are widely used in laser technology to generate new wavelengths or to improve beam quality.In four sections the essential nonlinear optical effects are discussed: frequency conversion in crystals, frequency conversion in gases and liquids, stimulated scattering and phase conjugation. In extensive tables the coefficients of the nonlinear processes are compiled.

August 2005 The Editors

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